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The Lidar Cyclops Syndrome Bypassed: 3D Wind Field Measurements from a Turbine mounted Lidar in combination with a fast CFD solver

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Abstract: Although a single Lidar can scan the line-of-sight projected wind components at multiple points upwind in front of a rotating wind turbine, it is in principle not possible to resolve all three wind components of the wind velocity vectors simultaneously from a single lidar.

This is known as the “Lidar Cyclops syndrome” with reference to the one-eyed Cyclops in old Greek mythology.

However, by feeding a single lidar’s line-of-sight (LOS) rotor plane scanned wind speeds to a fast CFD solver, it has been possible to determine the entire 3D velocity vectors at each measurement point consistent with a single lidars LOS wind speed measurements.

This talk will show it is possible to calculate the axial wind components in the measurement plane upwind in the rotor plane. The axial wind component is the most important for steering and control of the turbine, but also the transverse and the vertical wind component can easily be calculated simultaneously in a consistent matter. The linearized CFD model used is a linearized Fourier version of Navier-Stokes equations (LINCOM) which conserves mass and momentum. Following a full rotor plane lidar scan consisting of 400 LOS wind speed measurements The LINCOM CFD model is extremely fast solved for all three wind components, cf. the figures below.

A 400 measurement point rotor plane scan with the DTU SpinnerLidar can be obtained in less than 1 s and the 3D LINCOM solver can then calculate the three wind components in a split second. As such, this methodology can be used in real-time for determination of the axial inflow from a single lidar scanning instrument mounted on the turbine. It has not escaped our notice that the methodology can be used for real-time advanced feed-forward control of turbines.

